Frontiers for Discovery in High Energy Density Physics

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Presented at

2008 Warm Dense Matter Winter School

Lawrence Berkeley National Laboratory
University of California

January 10, 2008

Recent National Studies on High Energy Density Physics

Two recent national studies identified research opportunities of high intellectual value in high energy density plasma science. Studies were commissioned by:

• National Academies - National Research Council (*Frontiers in High Energy Density Physics, - The X-Games of Contemporary Science* National Academies Press, 2003).

• Office of Science and Technology Policy's Interagency Working Group on the Physics of the Universe (National Task Force Report on High Energy Density Physics, July, 2004).

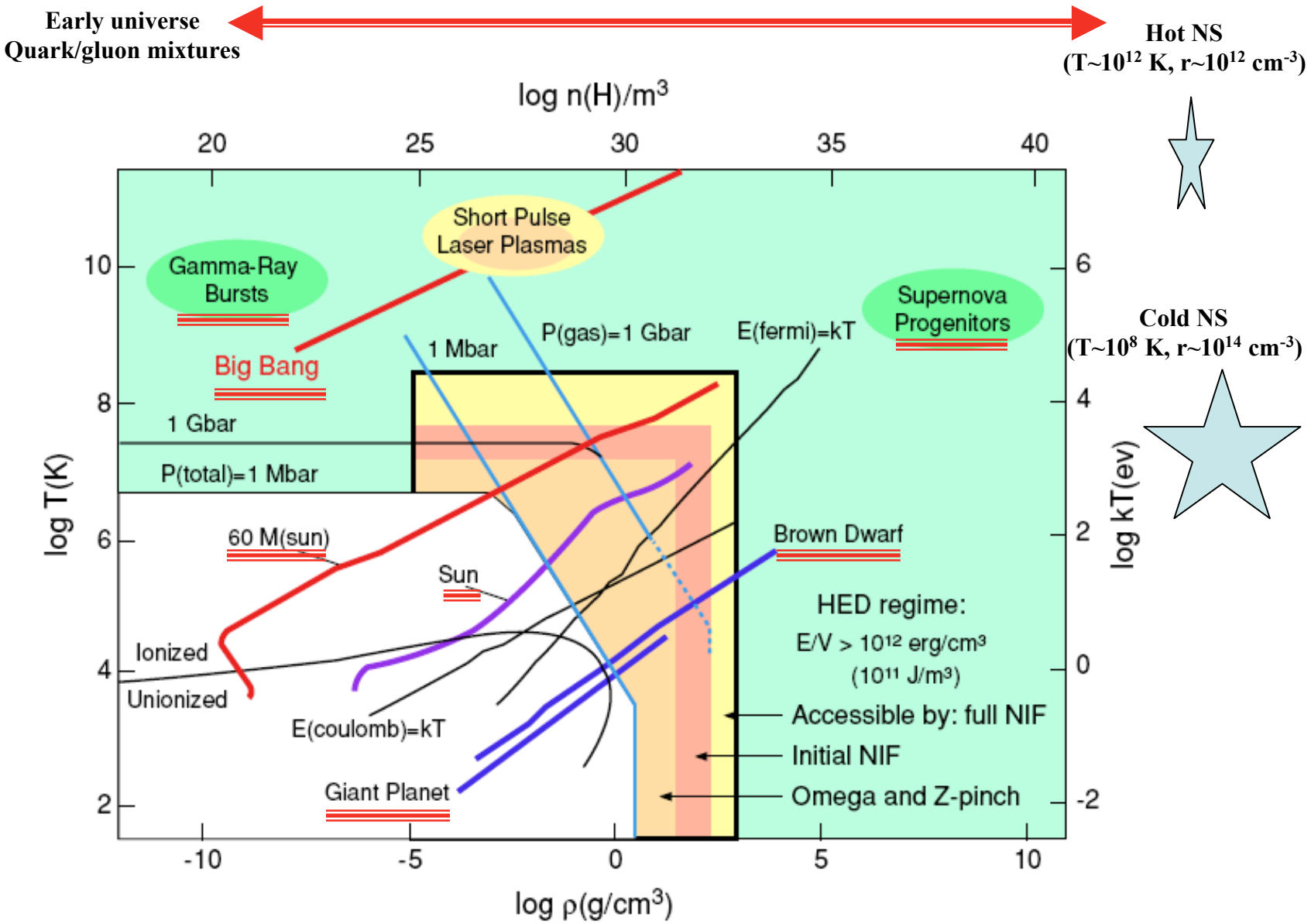
Scope of National Studies on High Energy Density Physics

High energy density experiments span a wide range of physics areas including plasma physics, materials science and condensed matter physics, atomic and molecular physics, nuclear physics, fluid dynamics and magnetohydrodynamics, and astrophysics.

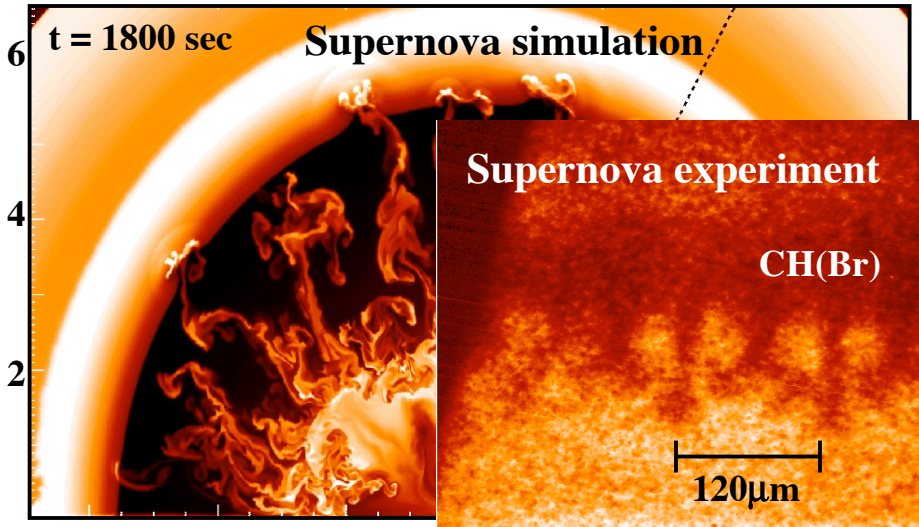
While a number of scientific areas are represented in high energy density physics, many of the techniques have grown out of ongoing research in plasma science, astrophysics, beam physics, accelerator physics, magnetic fusion, inertial confinement fusion, and nuclear weapons research.

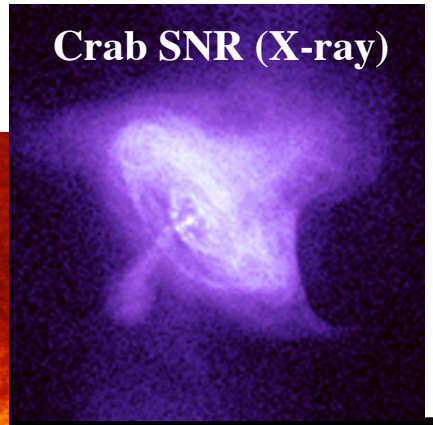
The intellectual challenge of high energy density physics lies in the complexity and nonlinearity of the collective interaction processes.

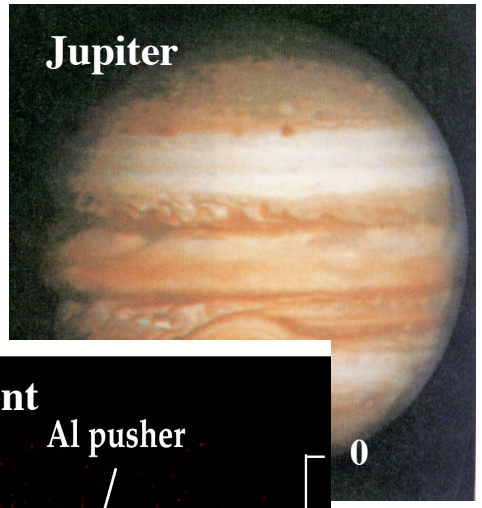
MAP OF THE HED UNIVERSE

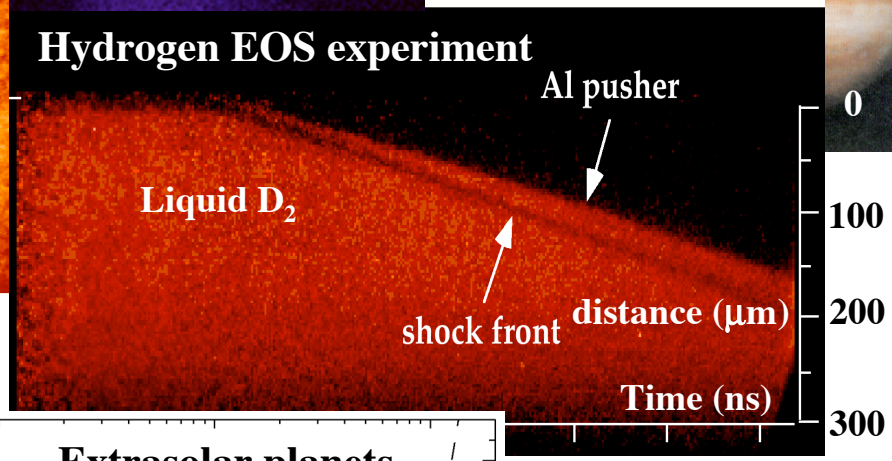


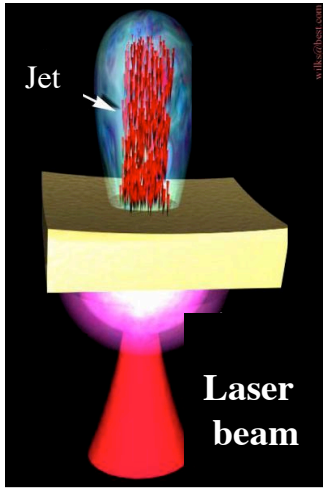
High Energy Density Plasma Science and Astrophysics





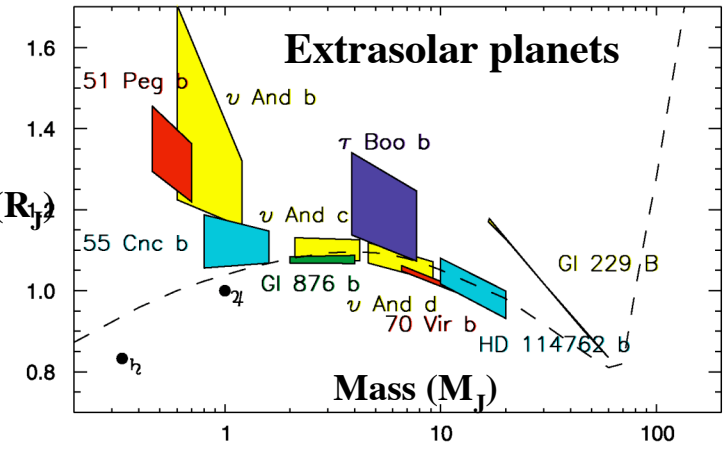




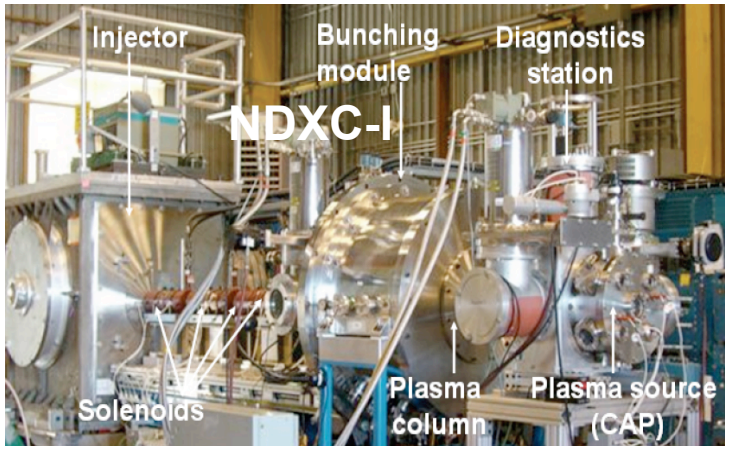


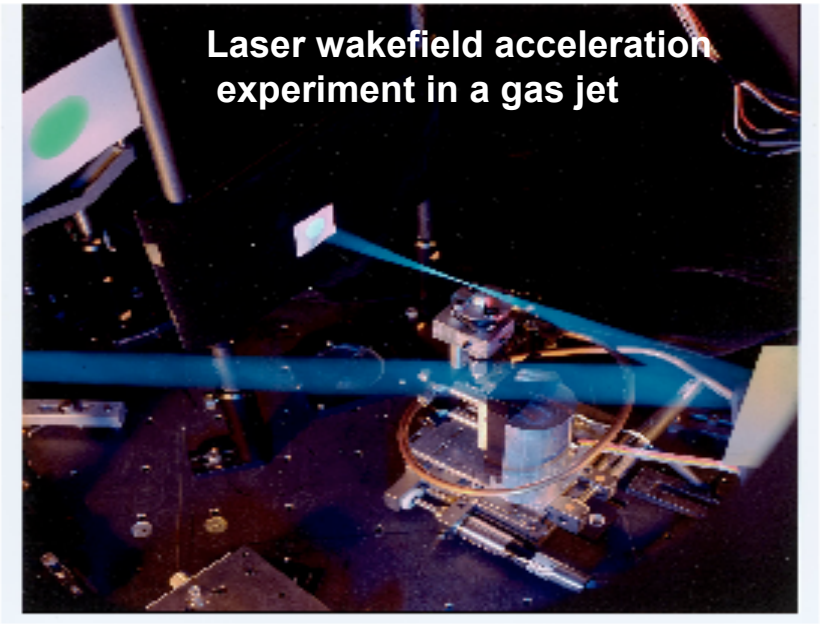
Au disk

Lab relativistic micro-fireball jet



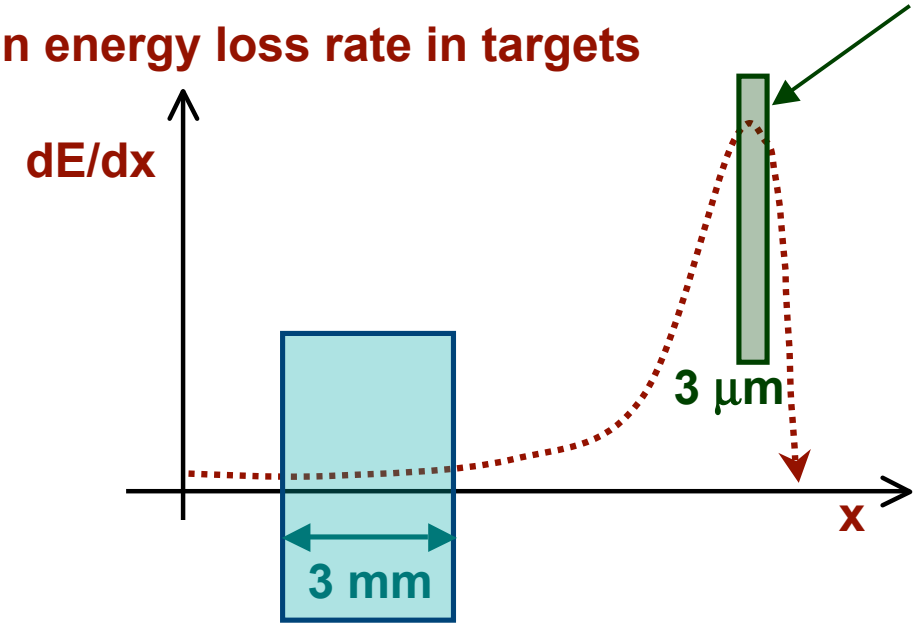
Facilities for Beam-Plasma and Laser-Plasma Interactions Range from Very Large to Tabletop Size





Developed unique approach to ion-driven HEDP with much shorter ion pulses (< few ns versus a few ms)

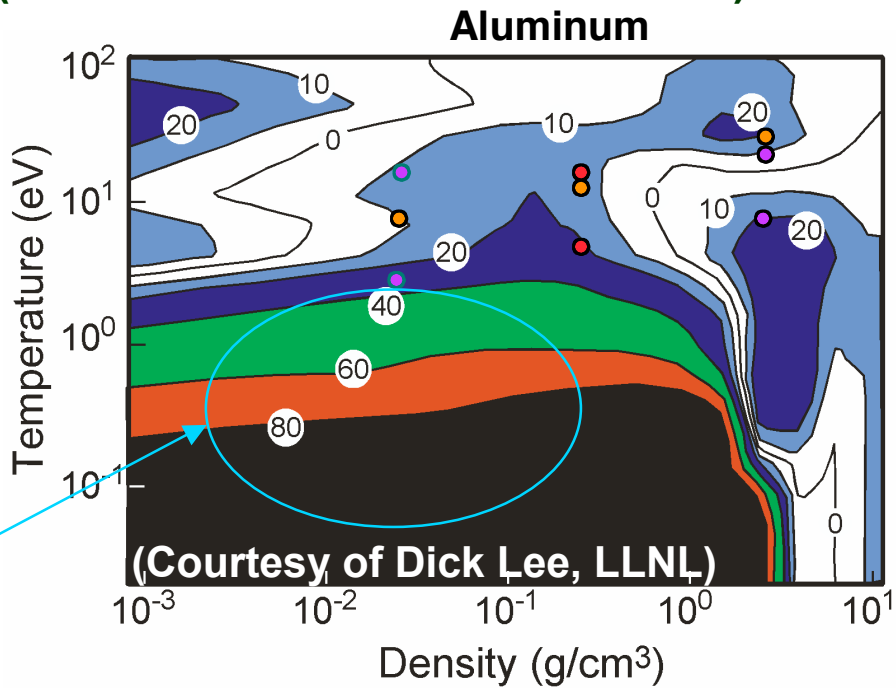
Ion energy loss rate in targets



GSI: 40 GeV heavy Ions→ thick targets→ Te ~ 1 eV per kJ

Dense, strongly coupled plasmas 10^{-2} to 10^{-1} *below* solid density are potentially productive areas to test EOS models (Numbers are % disagreement in EOS models where there is little or no data)

Maximum dE/dx *and* uniform heating at Bragg peak require short (< few ns) pulses to minimize hydro motion. [L. R. Grisham,PPPL (2004)].
→Te > 10 eV @ 20J, 20 MeV
(Future US accelerator for HEDP)



CONCLUSIONS

HEDP Task Force

High energy density plasma science is a rapidly growing field with enormous potential for discovery in scientific and technological areas of very high intellectual value.

The opportunities for graduate student training, postdoctoral research, commercial spin-offs, interdisciplinary research, and fusion energy applications are likely to increase for many decades to come.